

Small Wind Turbines

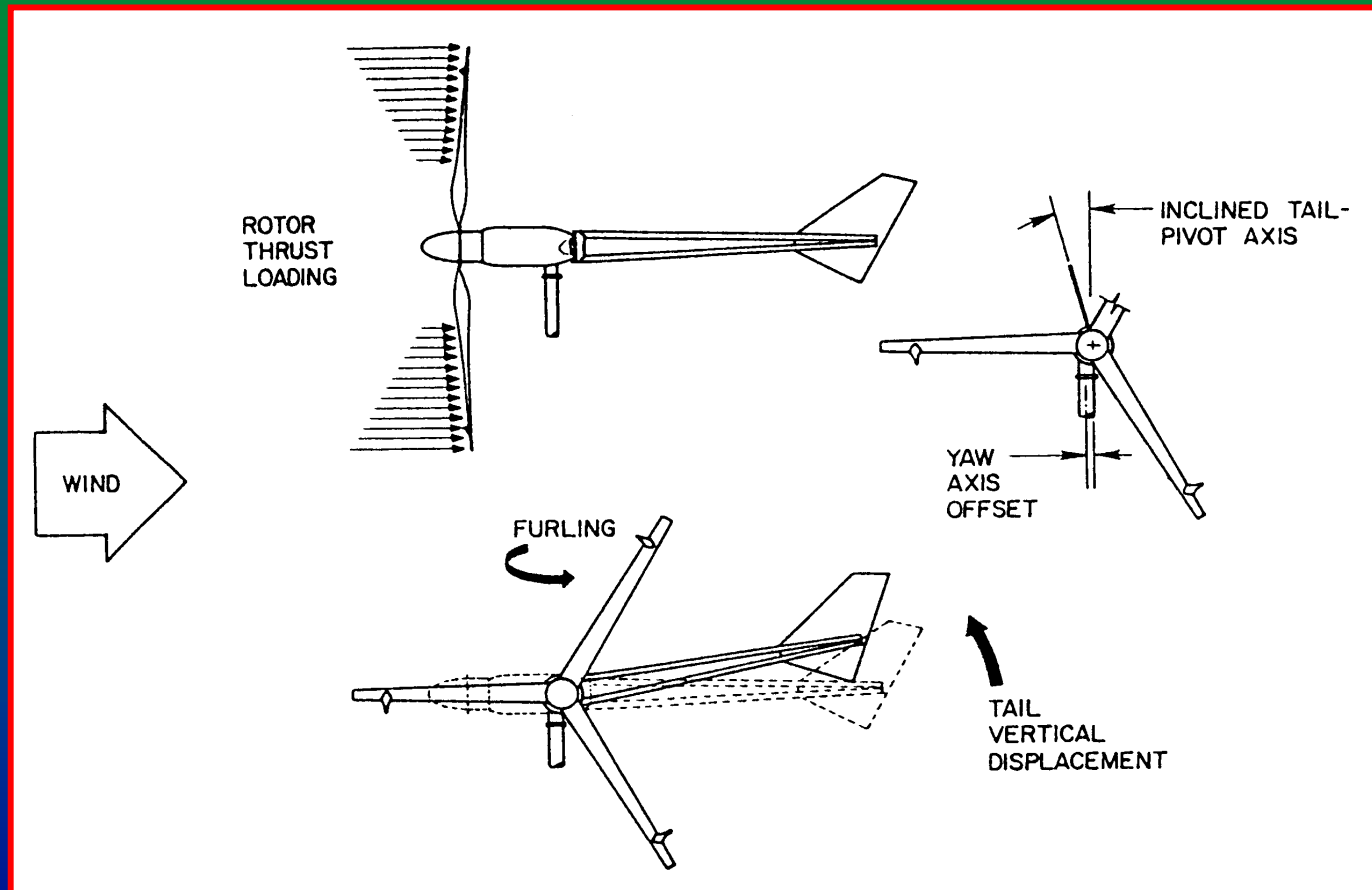
- **Configuration:** 2 or 3 blades aimed into the wind by the tail
- **Blades:** Fiber-reinforced plastics
- **Over-Speed Protection:** Furling (rotor turns out of the wind), no brakes
- **Generator:** Direct-drive, permanent magnet alternator (no brushes), 3-phase AC, variable-speed operation
- **Controller:** Electronic device that delivers
 - DC power for charging batteries
 - AC power for utility interconnection
- **Result:**
 - Simple, rugged design
 - Only 2–4 moving parts
 - Little regular maintenance required



Bergey EXCEL, 10 kW

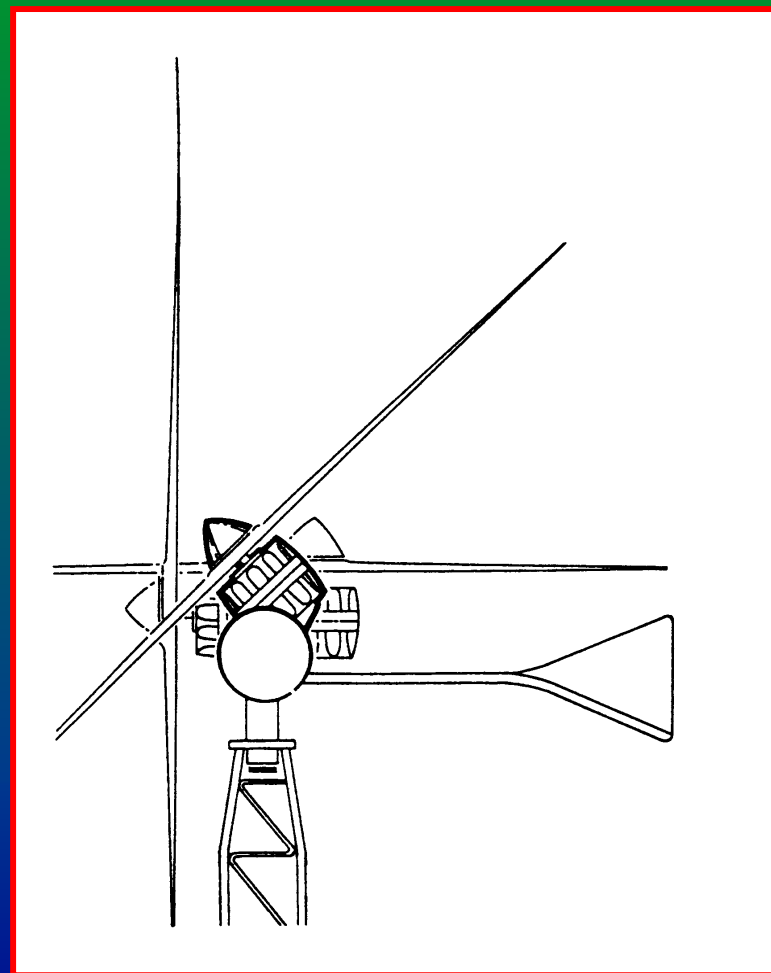
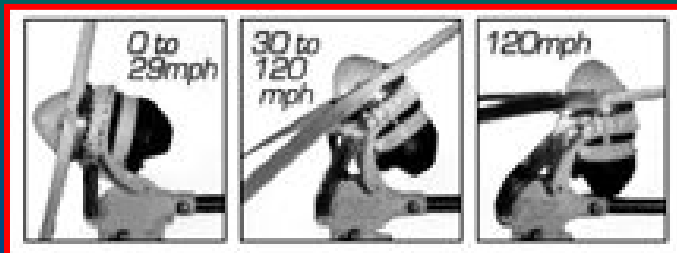
Over-Speed Protection During High Winds

- Side Furling: The rotor turns to one side under high winds



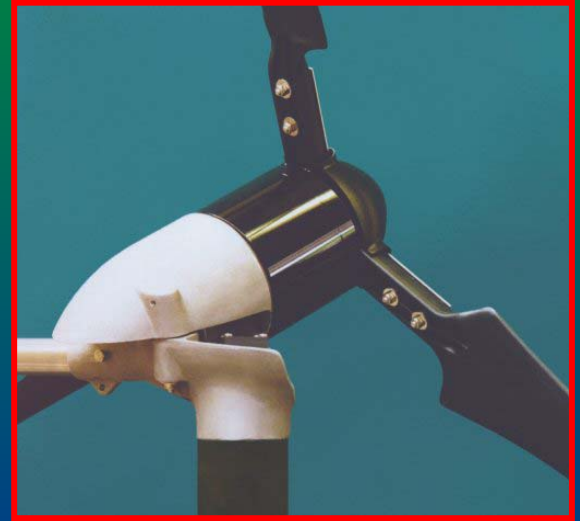
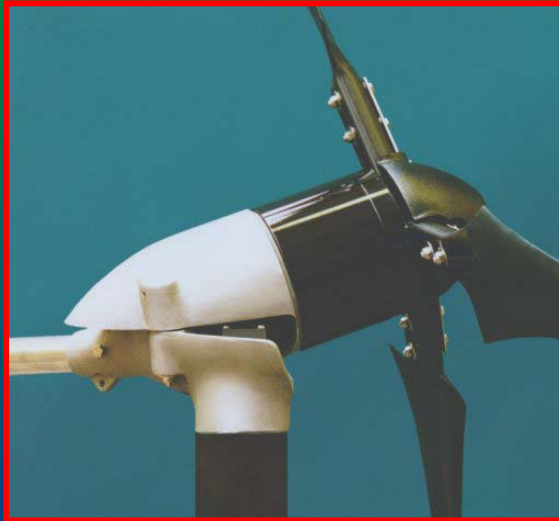
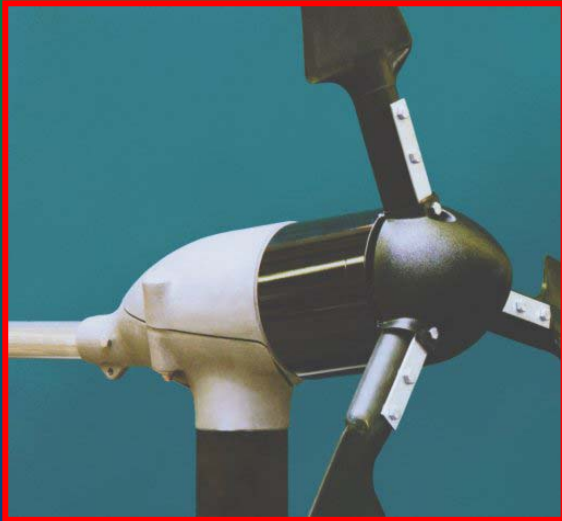
Over-Speed Protection During High Winds

- Upward Furling: The rotor tilts back during high winds

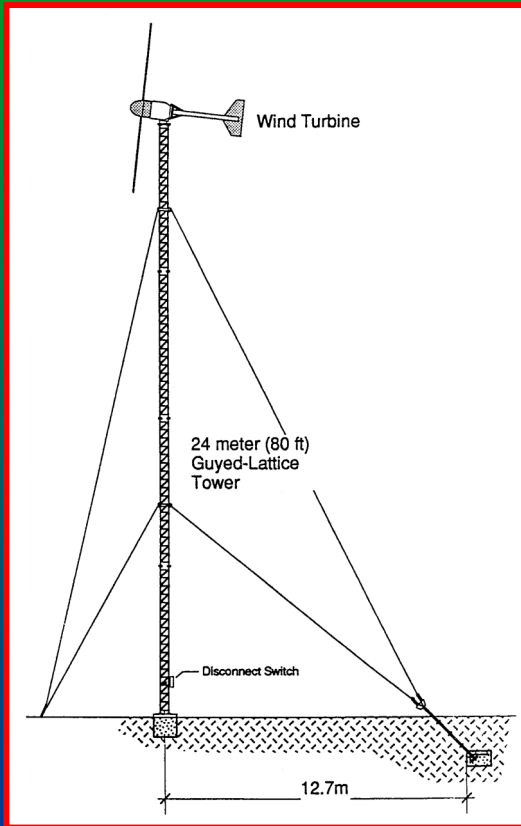


Over-Speed Protection During High Winds

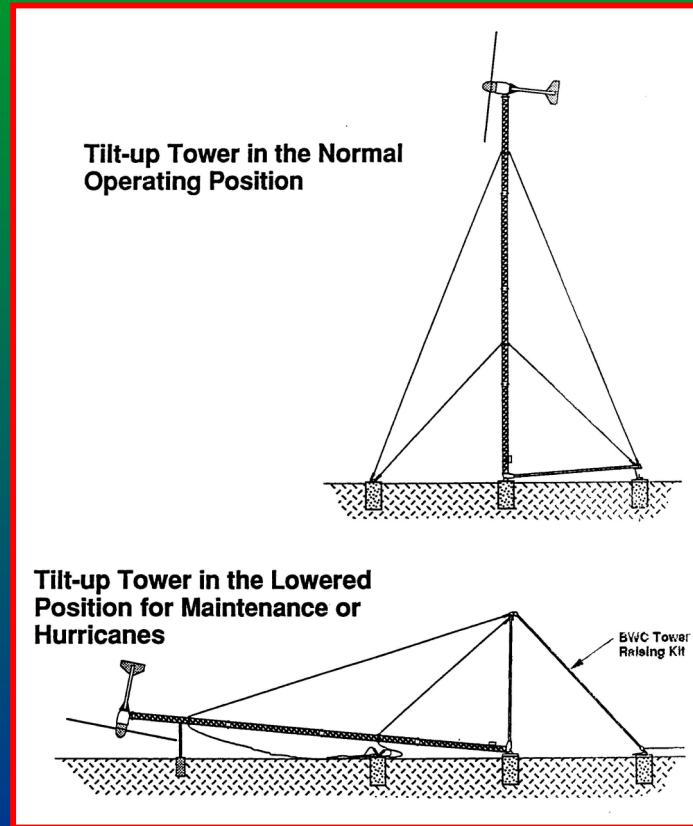
- Angle Governor: The rotor turns up and to one side



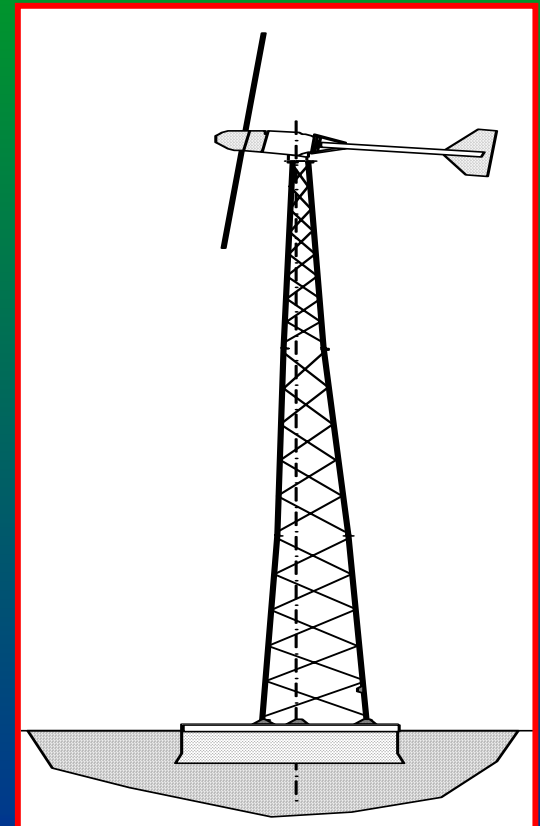
Small Wind Turbine Towers



Guyed Tower



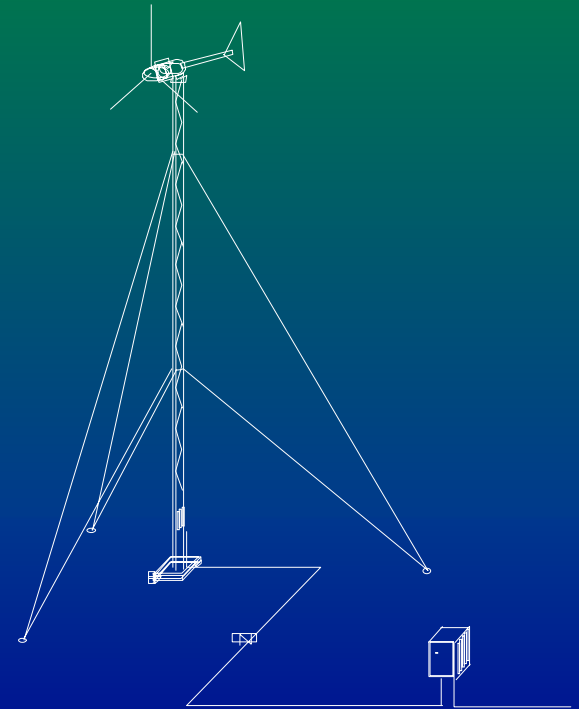
Tilt-Up Tower



Self-Supporting Tower

The Wind Turbine Controller

- Battery-Charging
 - Converts AC power to DC for charging batteries
 - Regulates the battery voltage to prevent overcharging
- When the battery is fully charged:
 - Power is diverted to another load, or
 - The rotor is unloaded and allowed to “freewheel”
- Grid Interconnection
 - “Inverter” converts the power to constant frequency 60 Hz AC
- UL label may be required



Small Wind Turbine Maintenance and Lifetime

- “Low Maintenance” not “No Maintenance”
 - Inspection and maintenance every 1-2 years
 - Inspect mechanical and electrical connections, check for corrosion, check guy wire tension, inspect/replace leading-edge tape, etc.
 - Beyond 10 years: blade or bearing replacement may be needed
- Lifetimes of 10 to 30 years expected with proper installation and regular maintenance

“A wind turbine will see as many operating hours in one year as an automobile will see in 200,000 miles!”

Small Wind Turbine Cost & Warranties

- Installed cost is between \$3,000 and \$6,000/kW for a small wind turbine with controller and tower.
- There is a trade-off between the incremental cost of a taller tower and increased energy output.
- Buyers must make judgments between initial cost and rugged/durable design.
- Warranties
 - 2-5 years
 - Coverage of “materials and workmanship”

